GPS-only gravity field determination from GOCE data

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IAG Scientific Assembly

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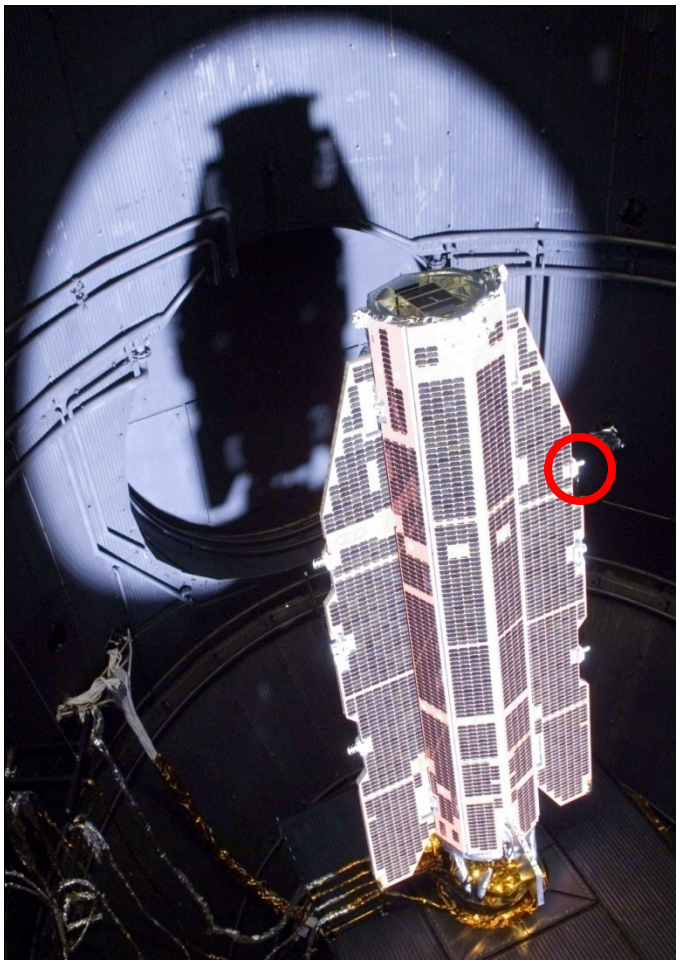
Background and motivation

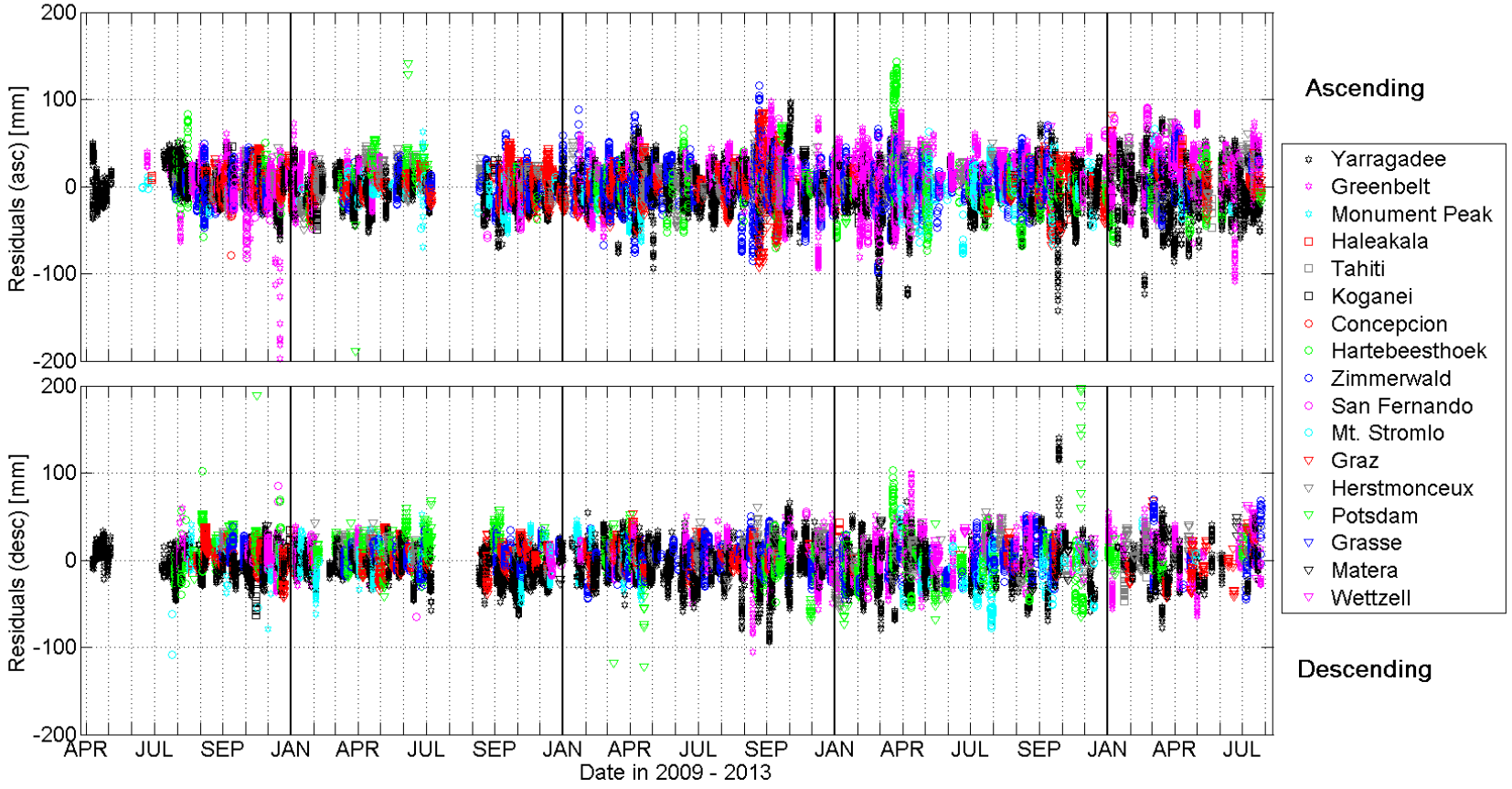


Courtesy:ESA

- AIUB is responsible for the determination of the Precise Science Orbit (SST_PSO) product within the GOCE HPF consortium
- The kinematic orbit product (SST_PKI) is used for the determination of the low degrees of the Earth's gravity field => GPS-only gravity field solutions
- The "Celestial Mechanics Approach" (CMA) developed at AIUB allows it to directly test the performance of the GPS-only gravity field solutions

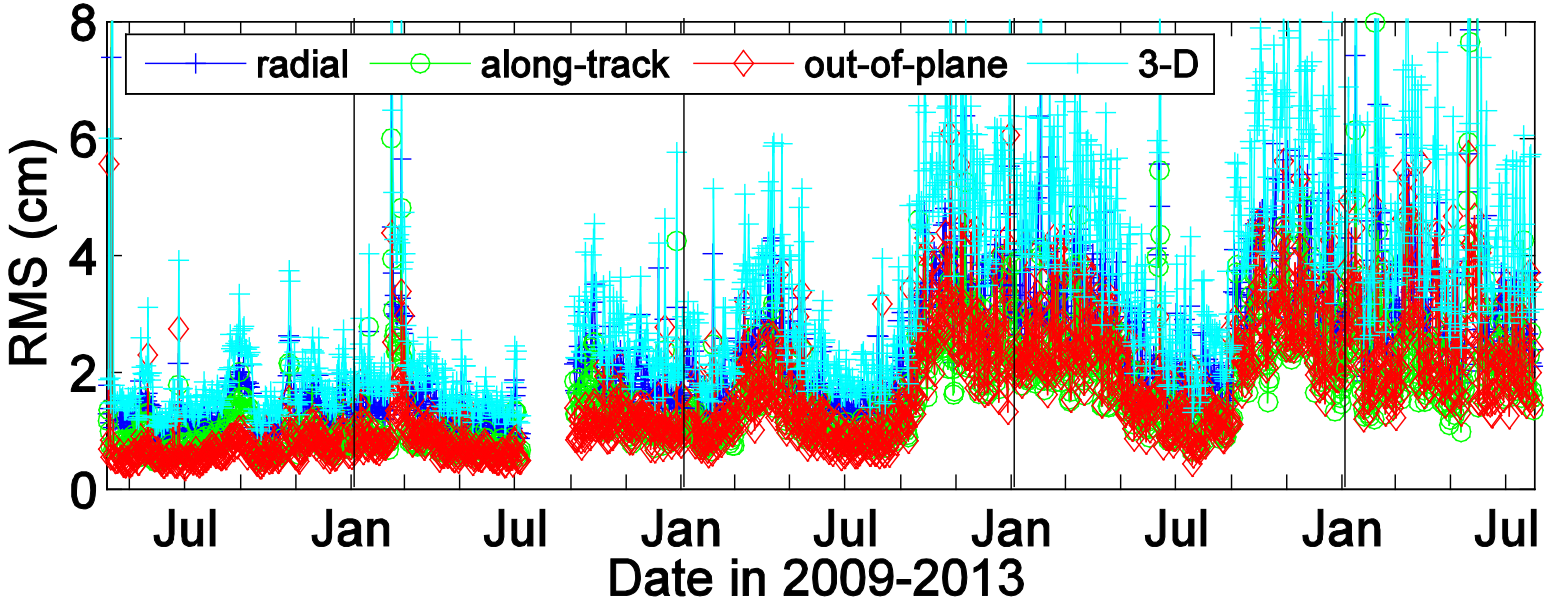
GOCE orbit determination – SLR validation

Kinematic orbits – SST_PKI



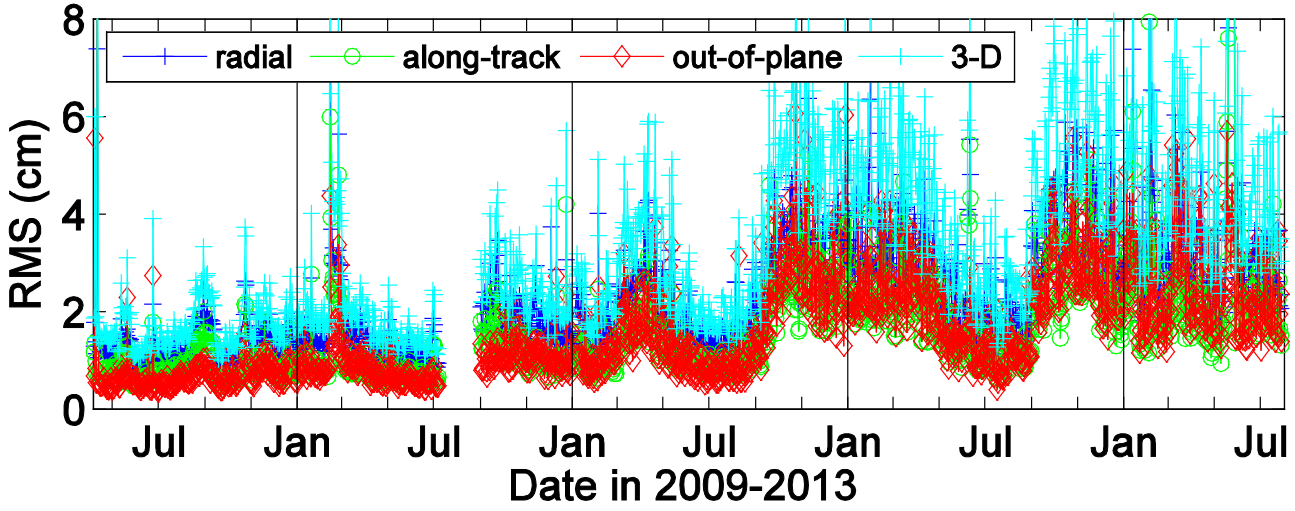
Mean: 0.08 cm **RMS: 2.36 cm**

GOCE orbit determination – results

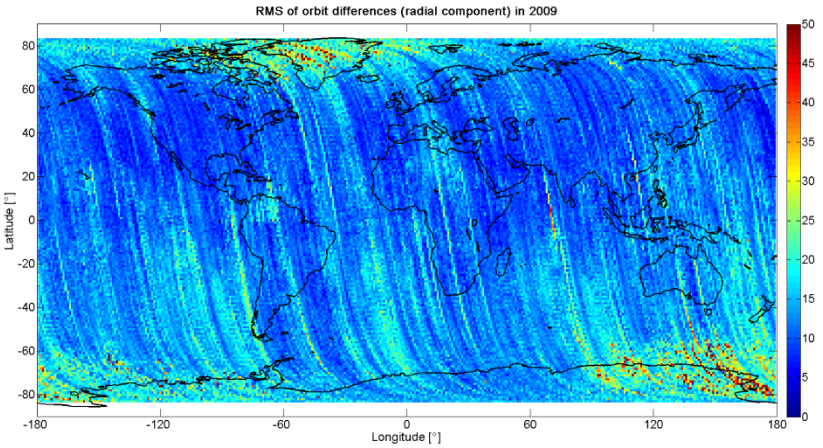


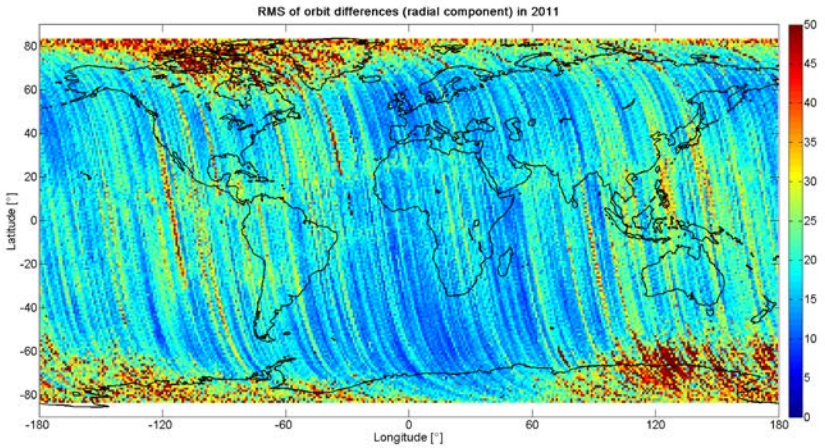
- RMS of the differences between reduced-dynamic and kinematic orbits
- RMS values are growing during the mission

GOCE orbit determination – results



2009 Radial RMS (ascending arcs) 2011





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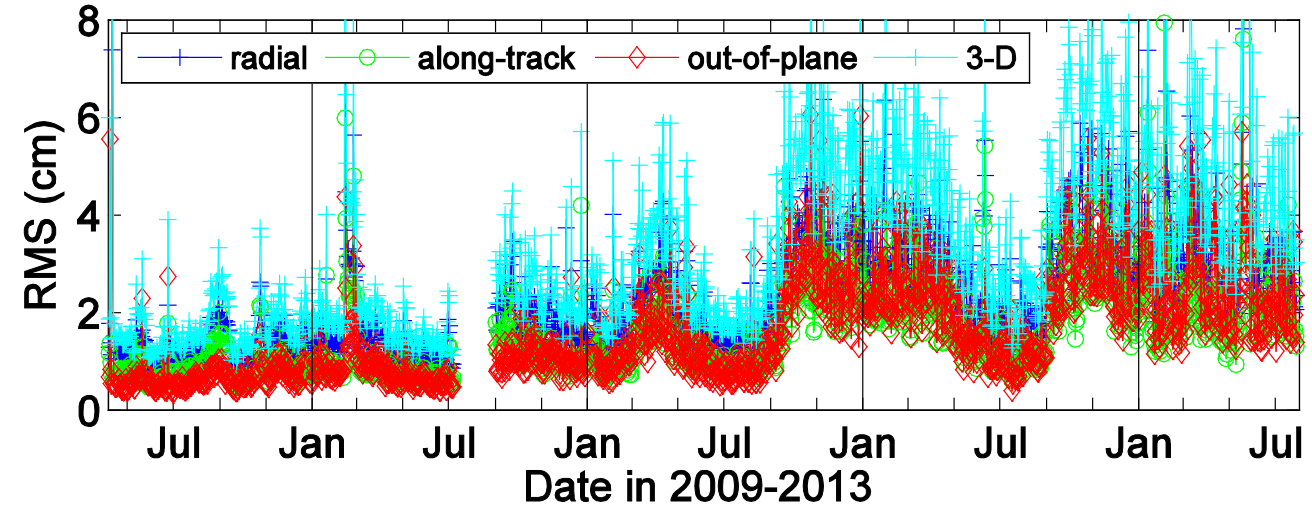
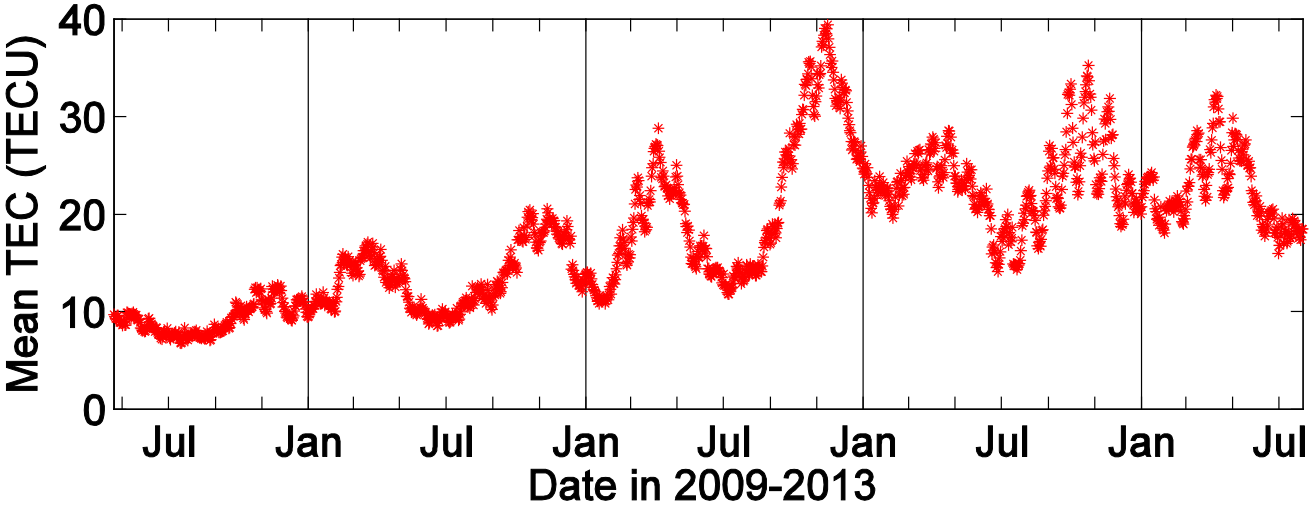
GOCE orbit determination – results





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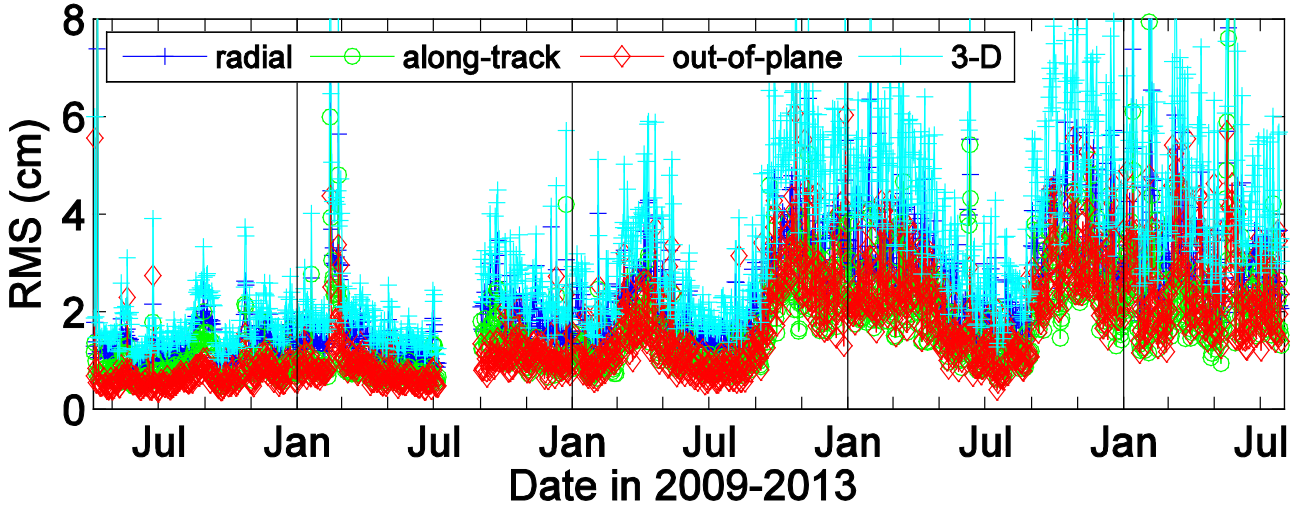
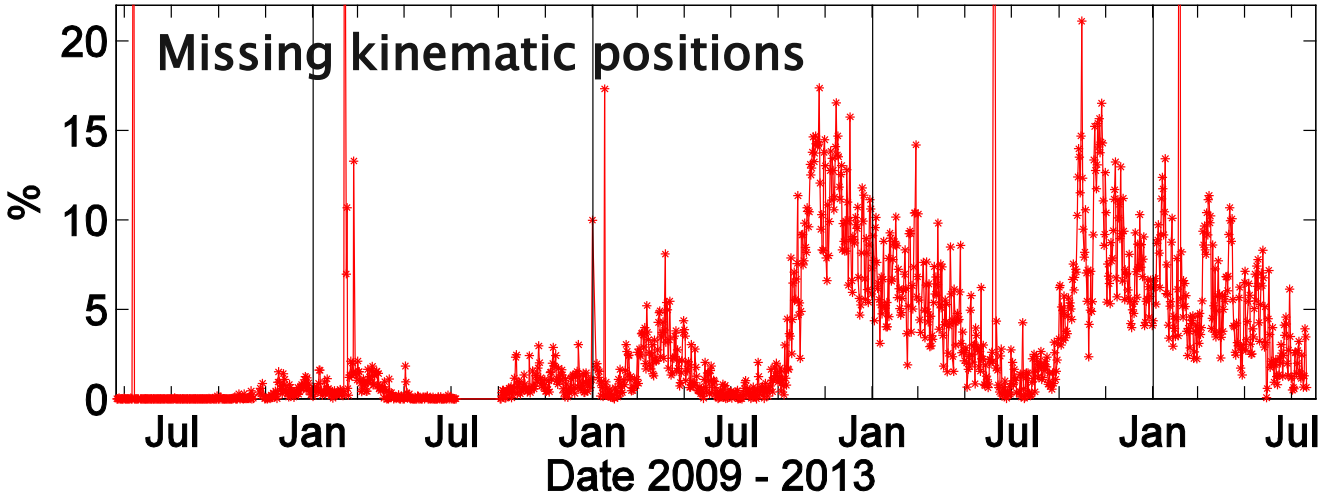




GPS-only gravity field determination

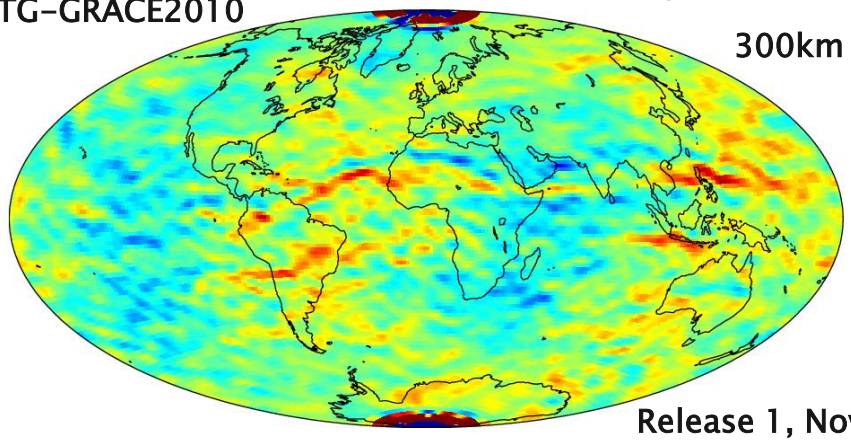
- Celestial Mechanics Approach
- Pseudo-observations: kinematic GOCE positions (SST_PKI) with variance-covariance information (SST_PCV) (+ common-mode accelerometer data)
- Parameters:
  - 6 initial orbit elements
  - Constant and once-per-revolution terms in R, S, and W
  - Pseudo-stochastic pulses in R, S, and W every 6 min (σ= 0.1mm/s)
  - Gravity field parameters up to degree/order 120

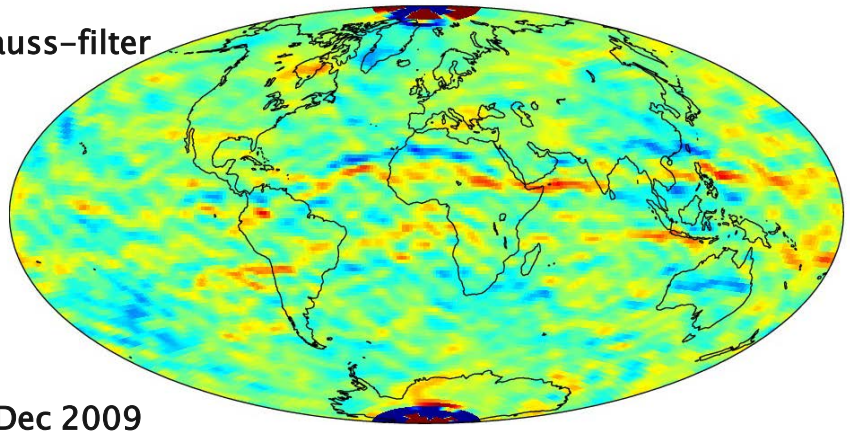
Impact of accelerometer data

Geoid differences to ITG-GRACE2010

Colour scale -0.05 .... 0.05 m

300km Gauss-filter





Release 1, Nov/Dec 2009

Standard

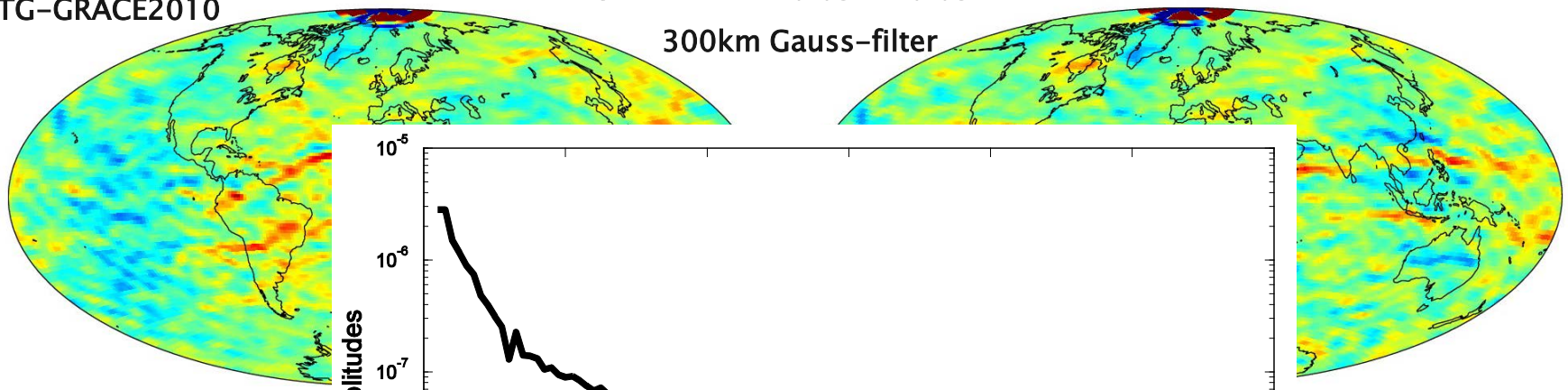
+ common-mode accelerometer data

Impact of accelerometer data

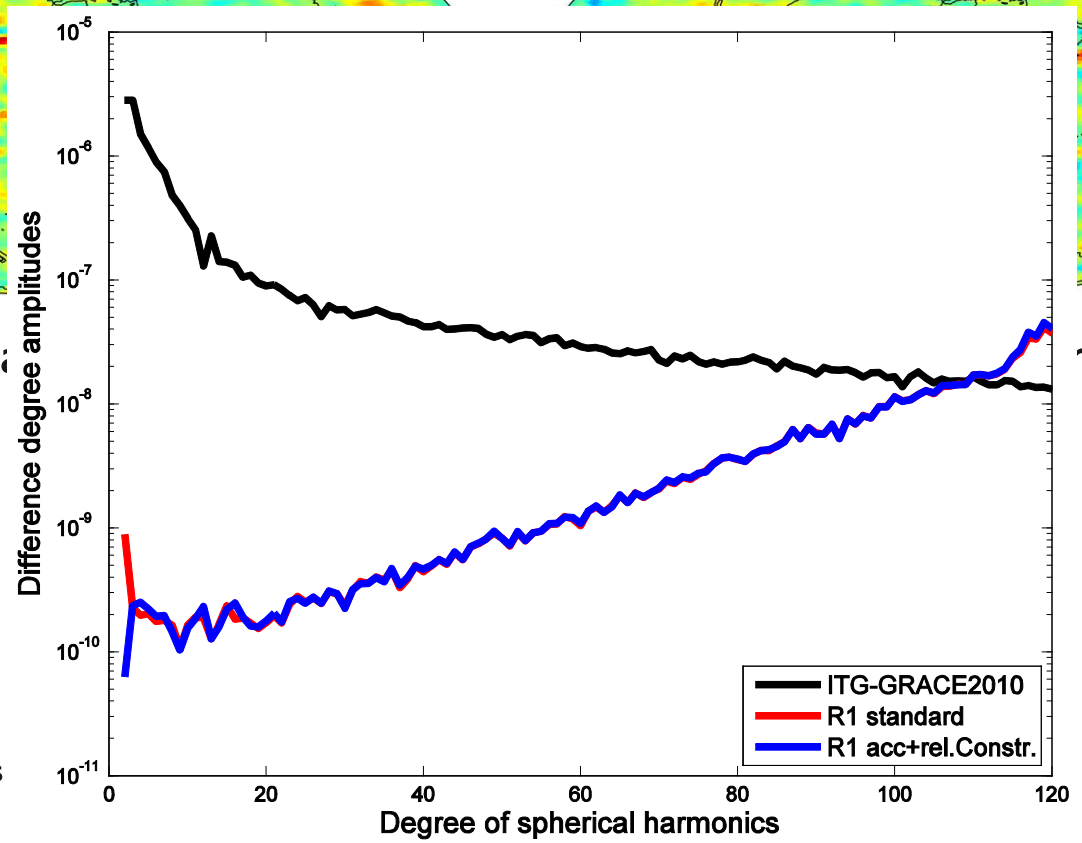
Geoid differences to ITG-GRACE2010

Colour scale -0.05 .... 0.05 m

300km Gauss-filter



Sta ometer data



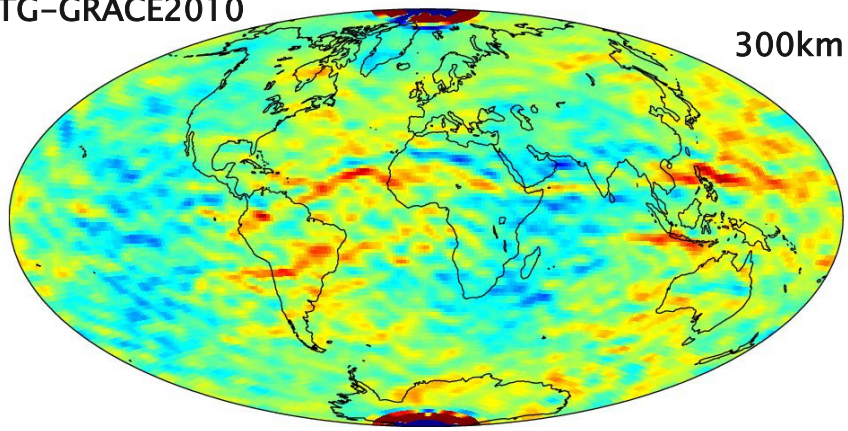
Zonal and near-zonal terms excluded according to Van Gelderen and Koop, 1997

Release 1 and Release 4 solutions

Geoid differences to ITG-GRACE2010

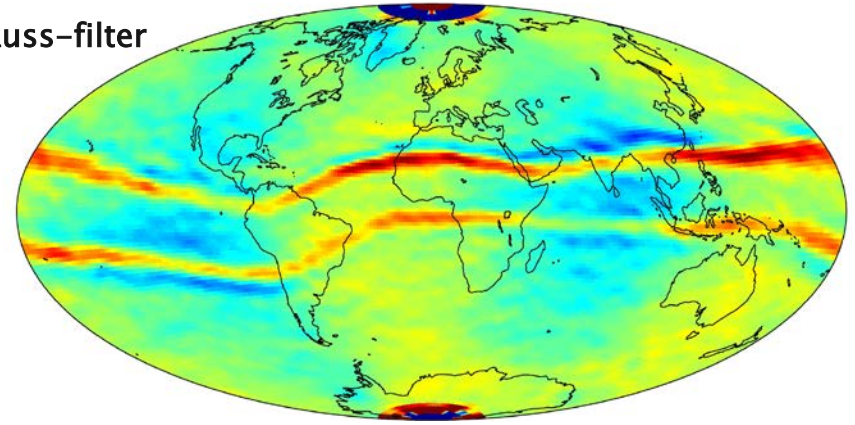
Colour scale -0.05 .... 0.05 m

300km Gauss-filter



Release 1

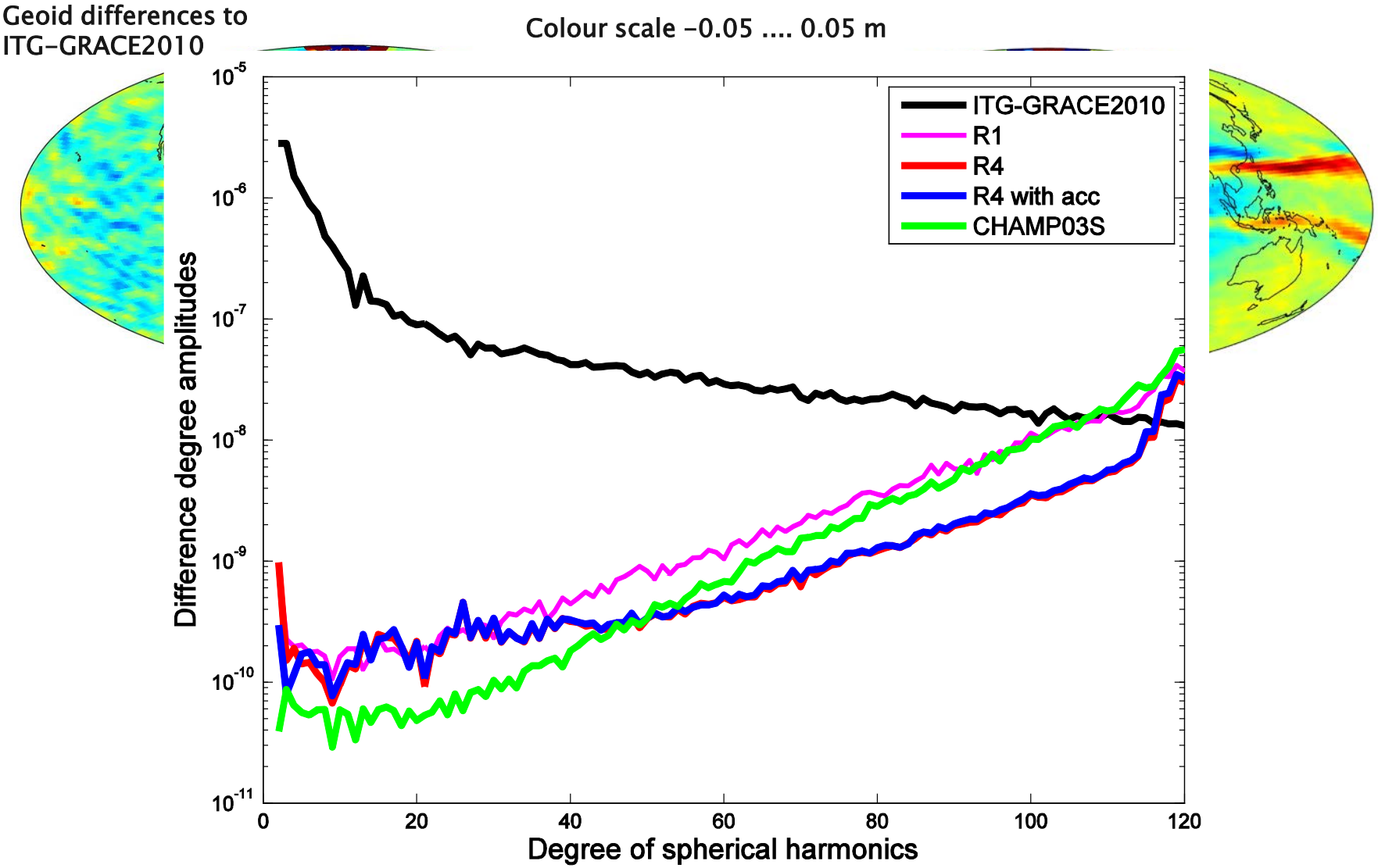
Nov-Dec 2009



Release 4

Nov 2009 - Jun 2012

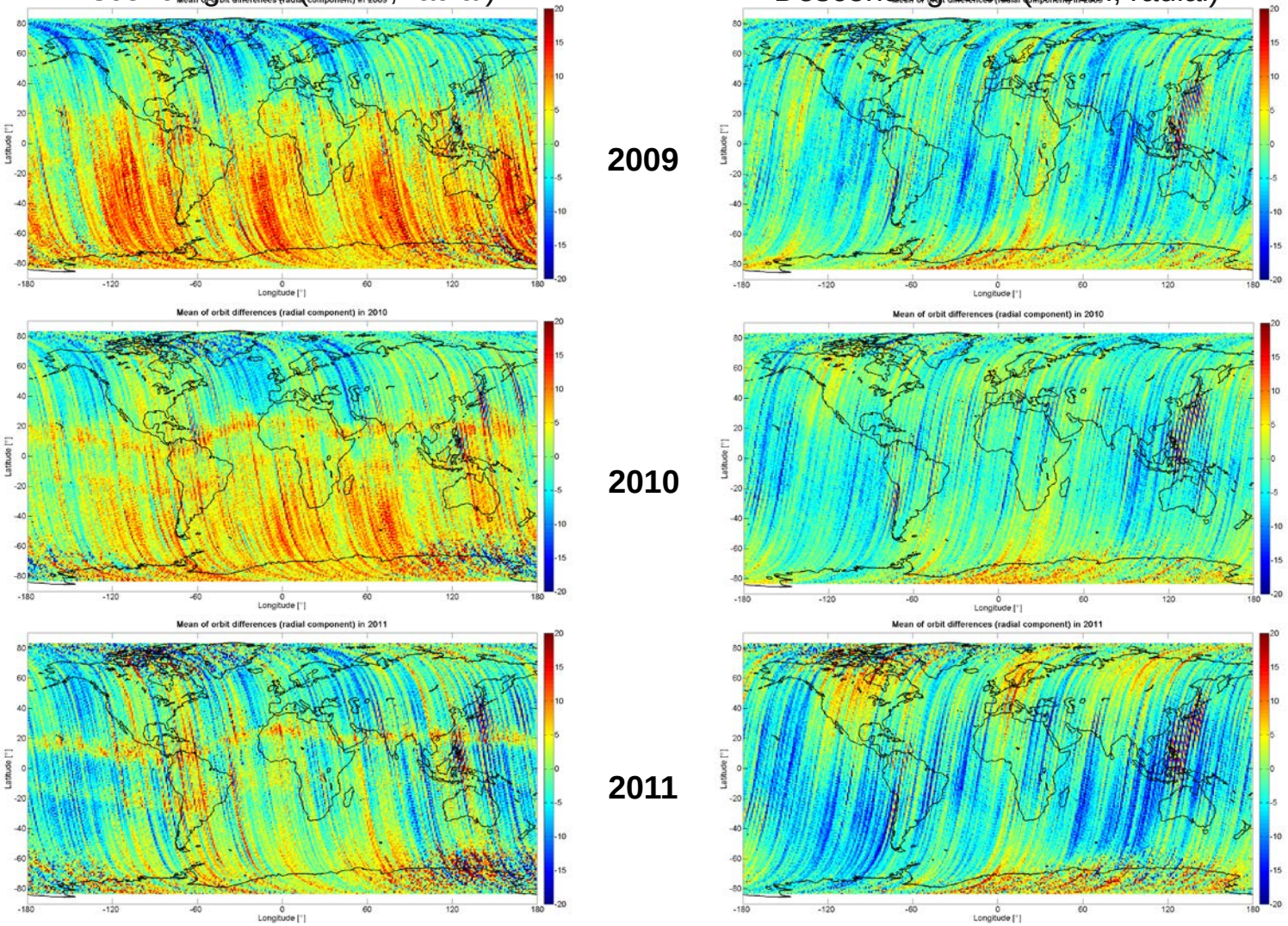
Release 1 and Release 4 solutions



Differences red.–dyn ⇔kinematic orbits

Ascending arcs (mean, radial)

Descending arcs (mean, radial)



2009

2010

2011

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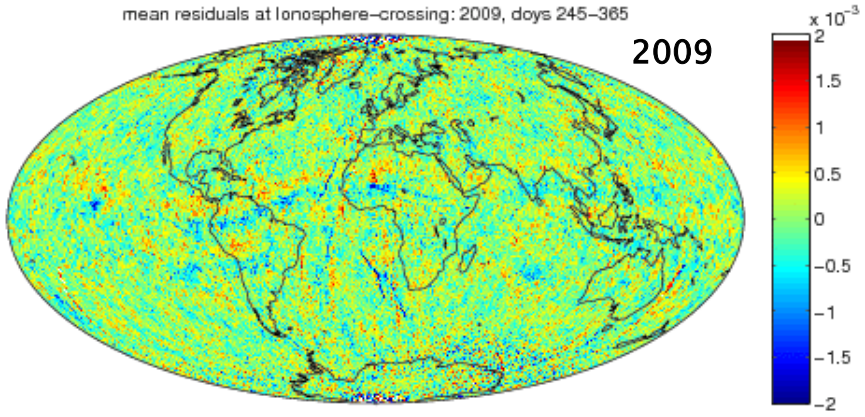
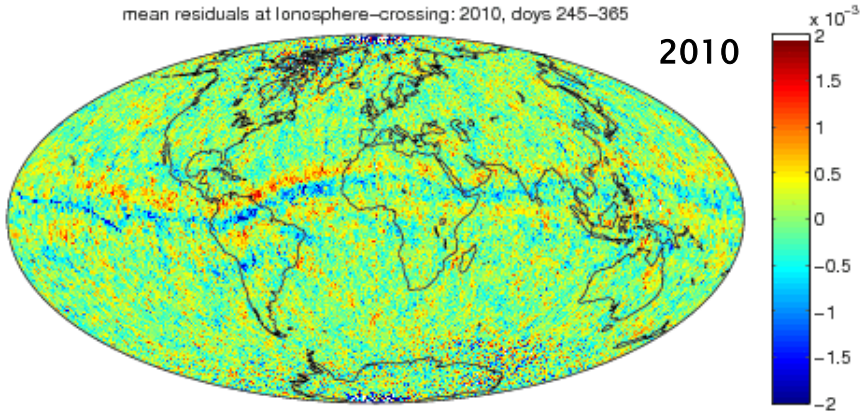
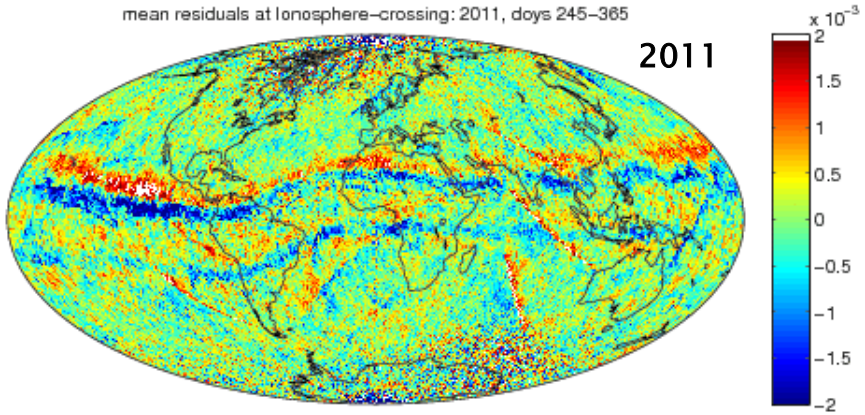
Phase observation residuals

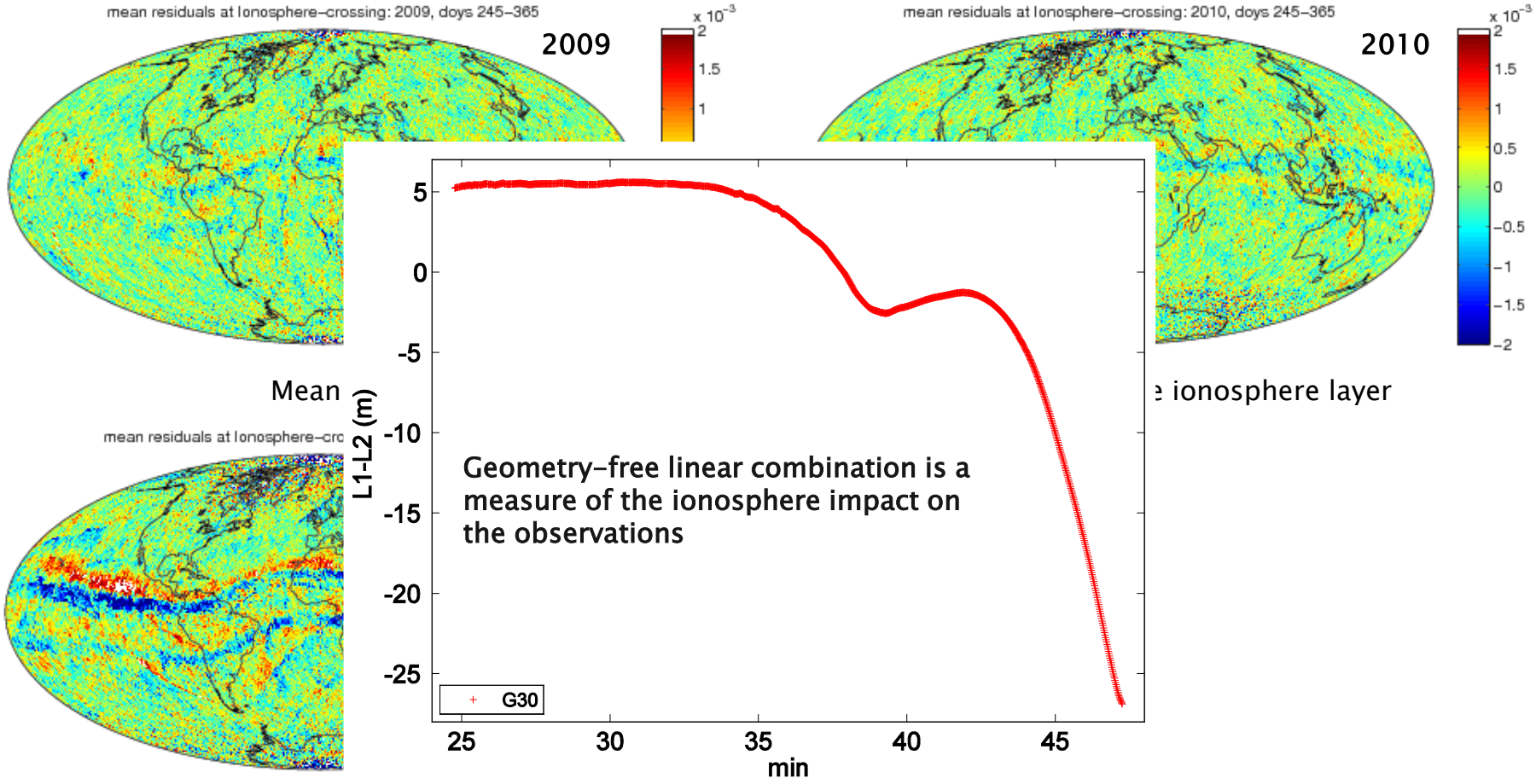




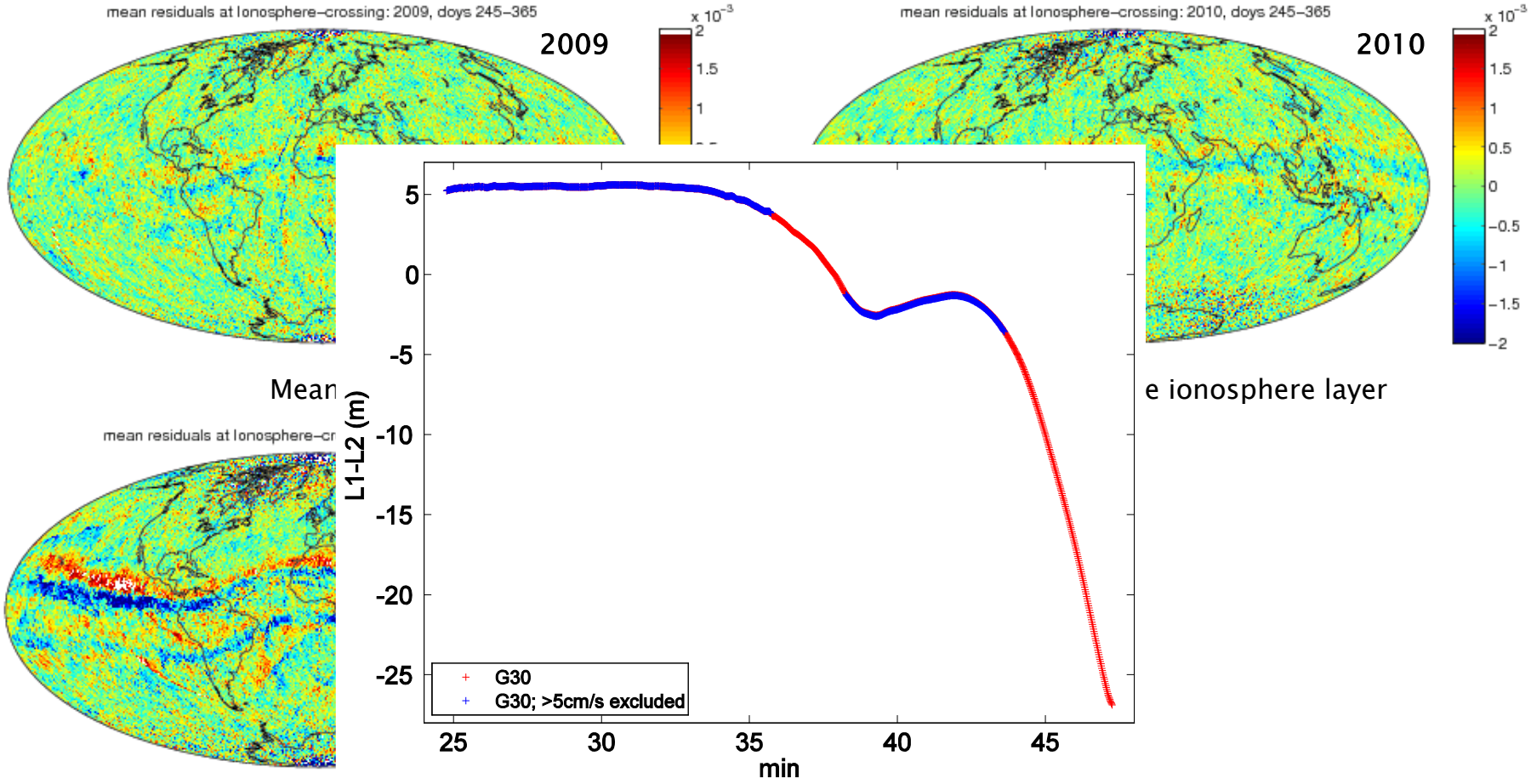
Mean of phase observation residuals mapped to the crossing of the ionosphere layer



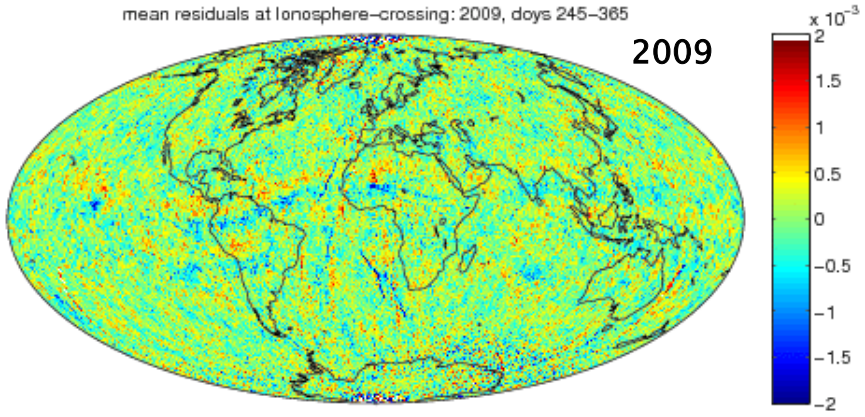
Phase observation residuals

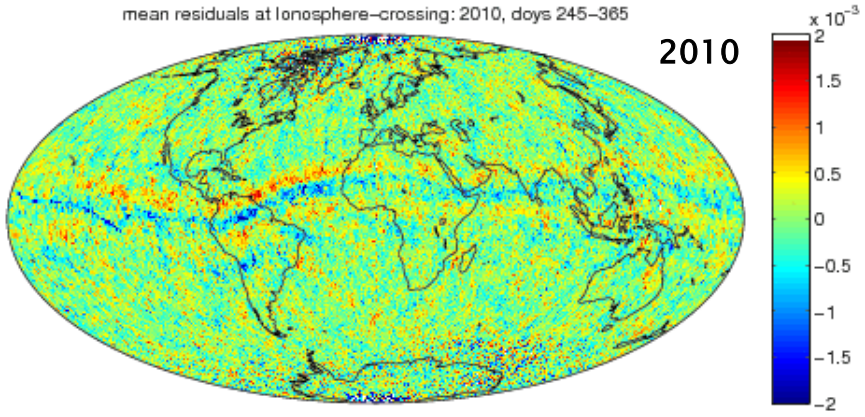


Phase observation residuals

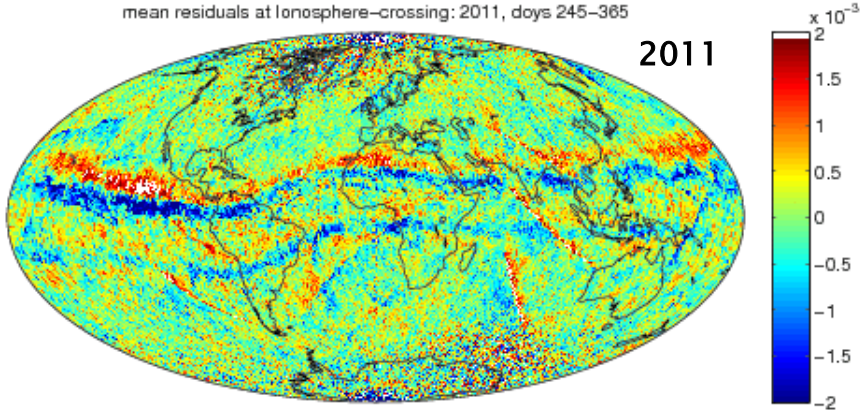


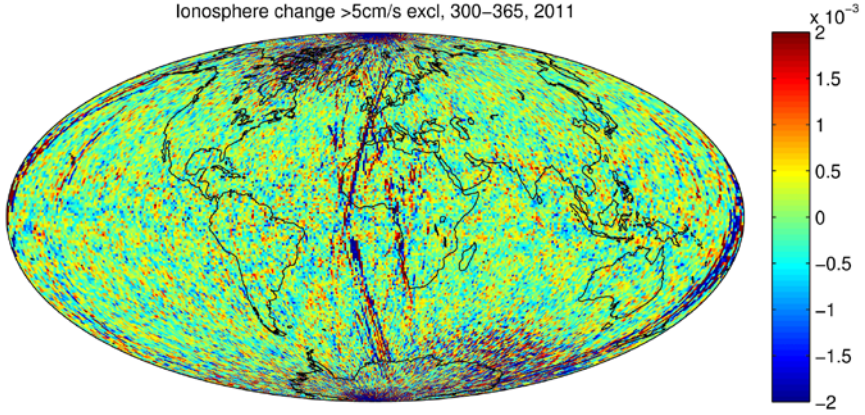
Phase observation residuals



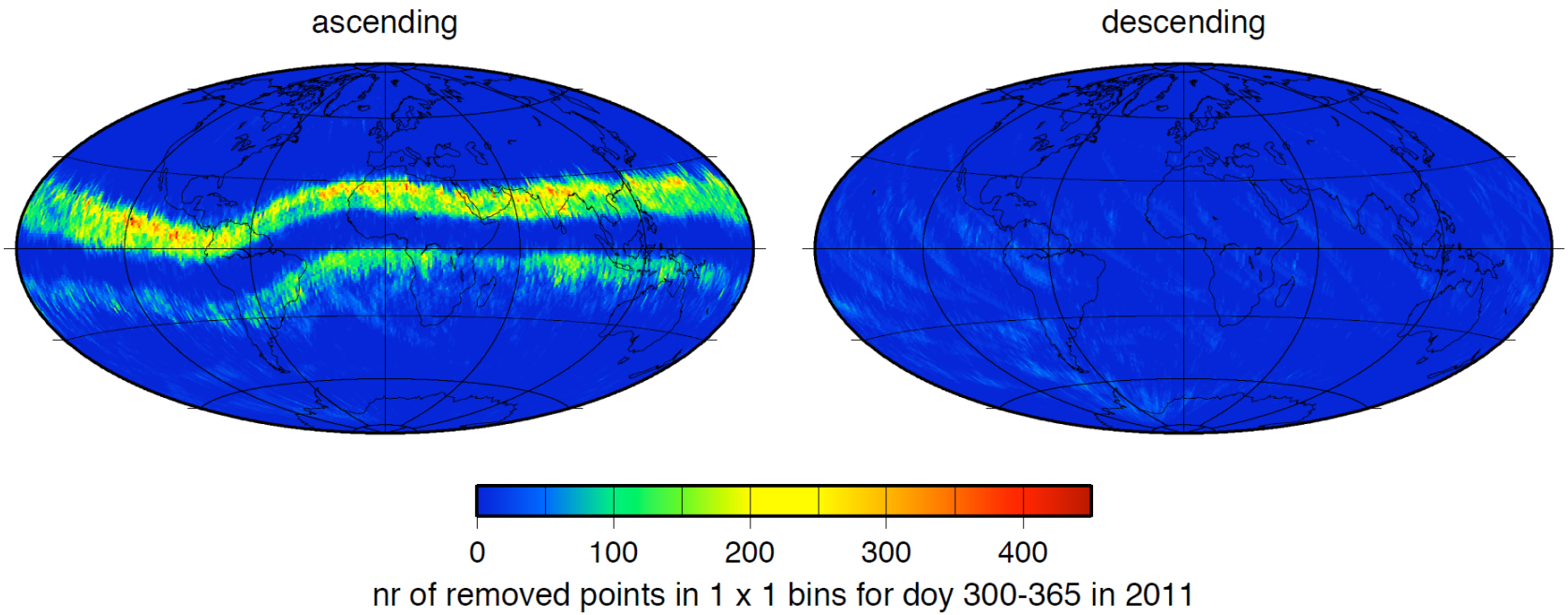


Mean of phase observation residuals mapped to the crossing of the ionosphere layer

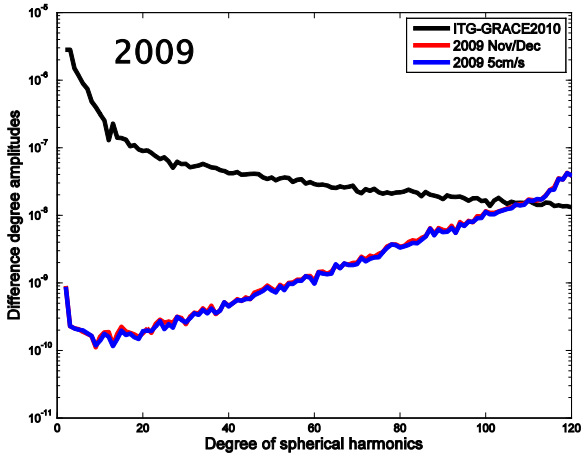


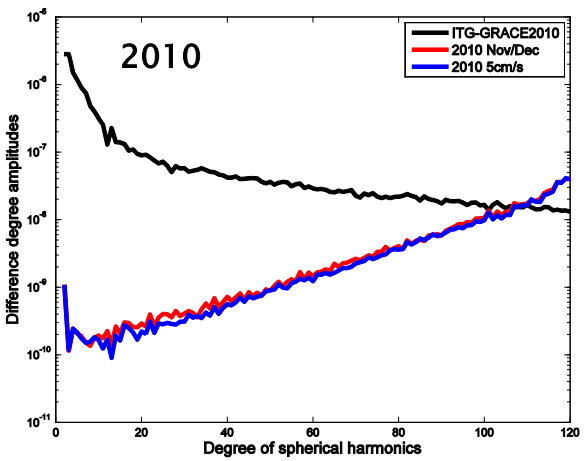


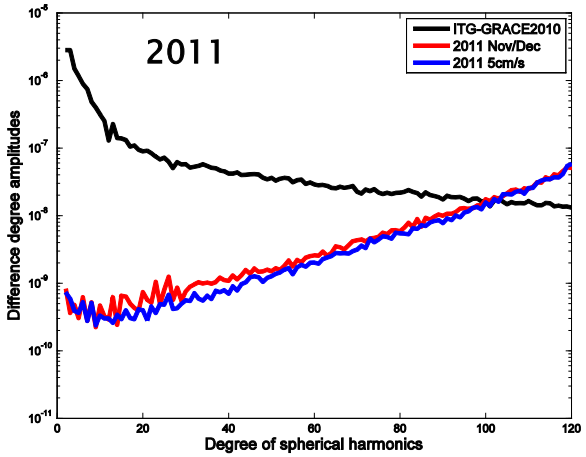
Number of removed observations

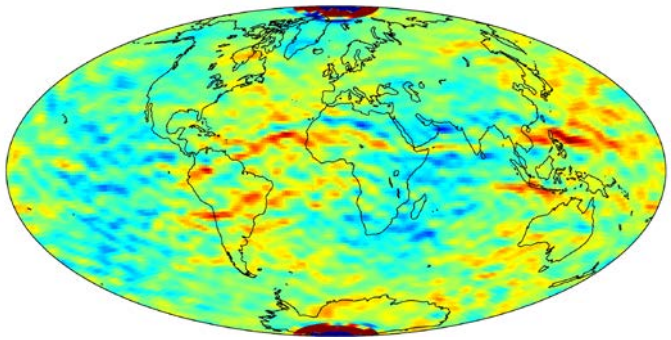


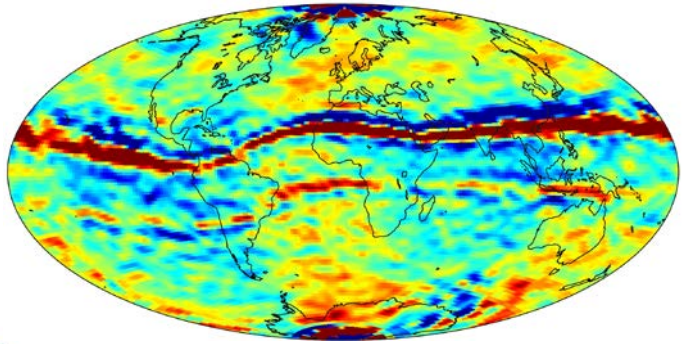
Removal of systematic orbit errors

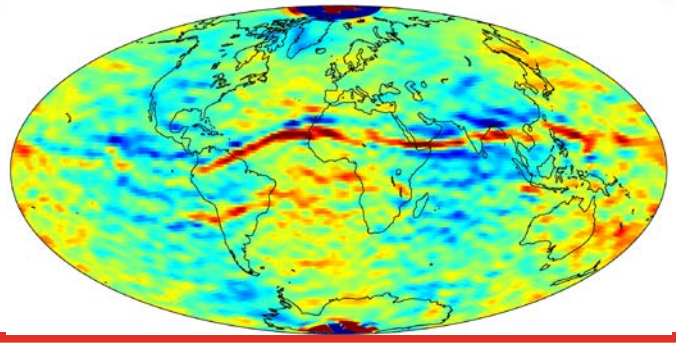




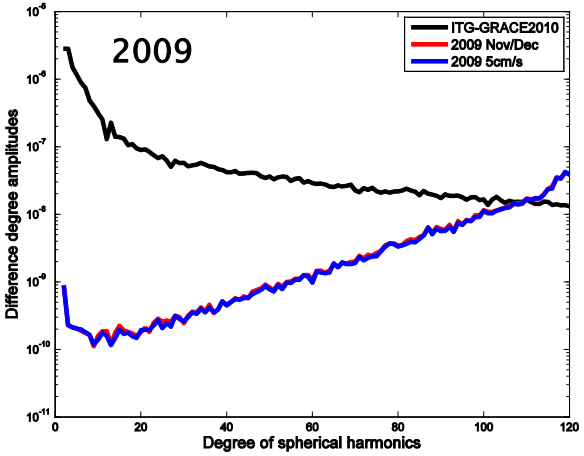


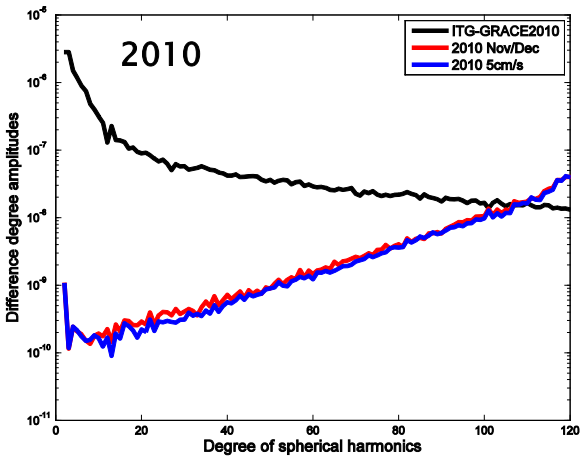


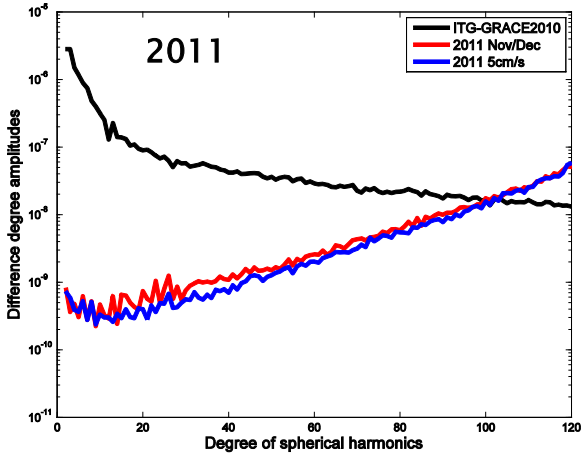


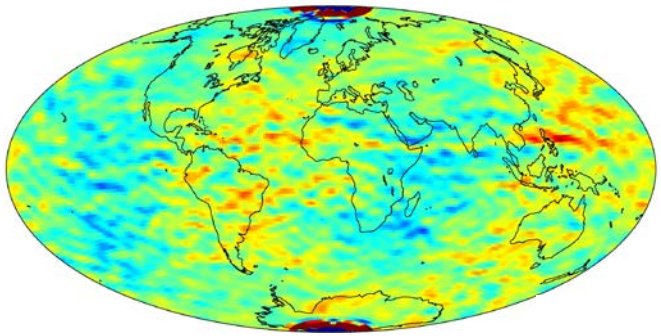


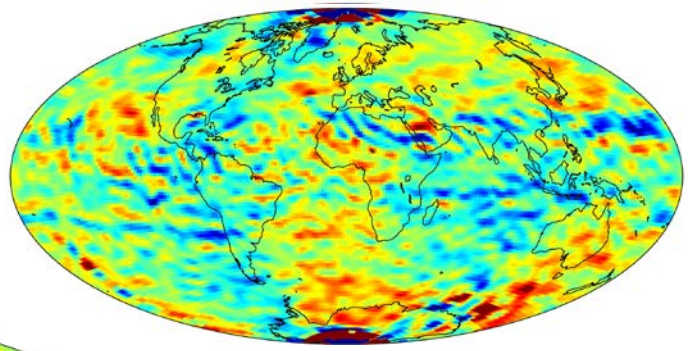
Removal of systematic orbit errors

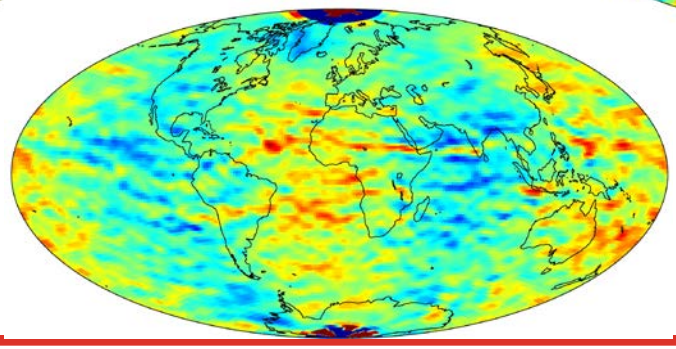












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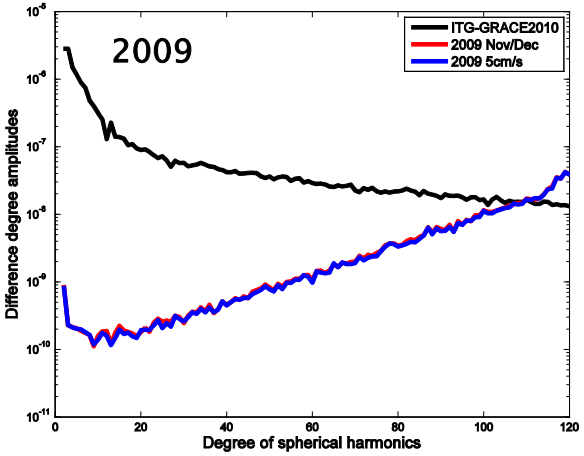

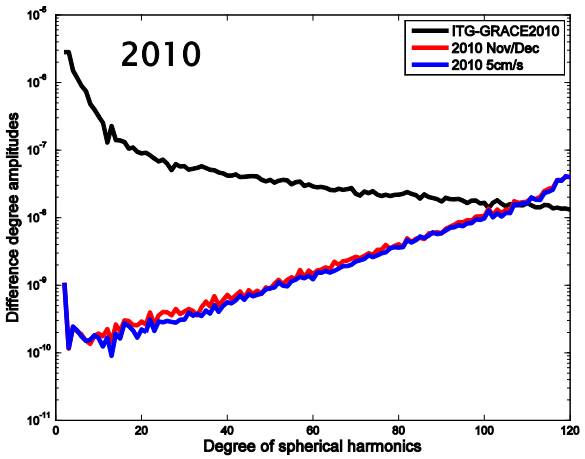

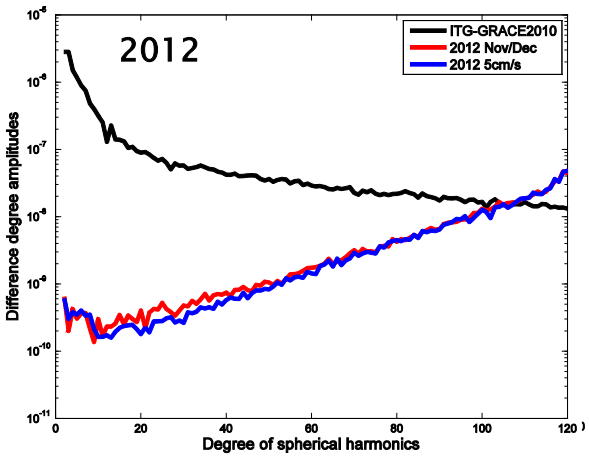

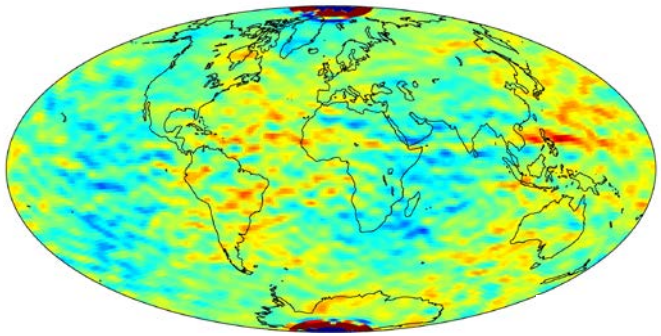

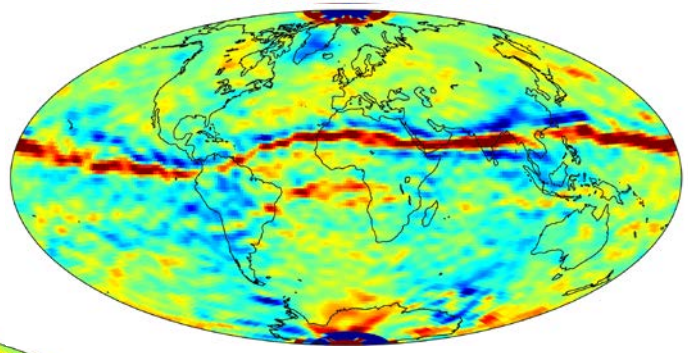

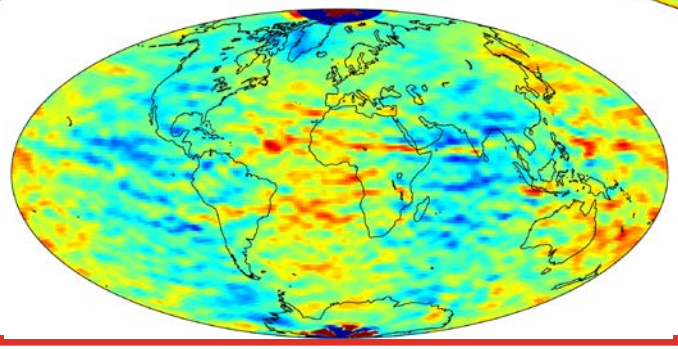

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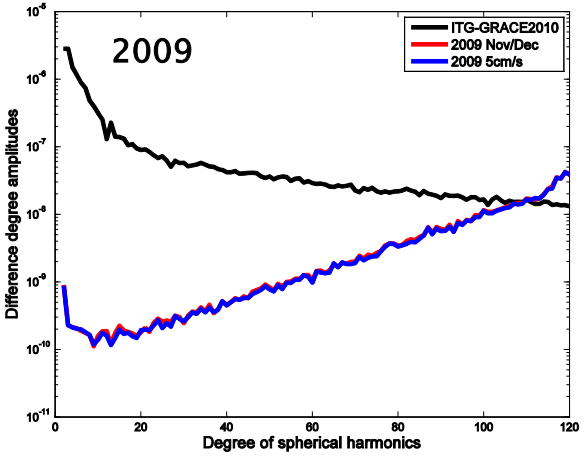
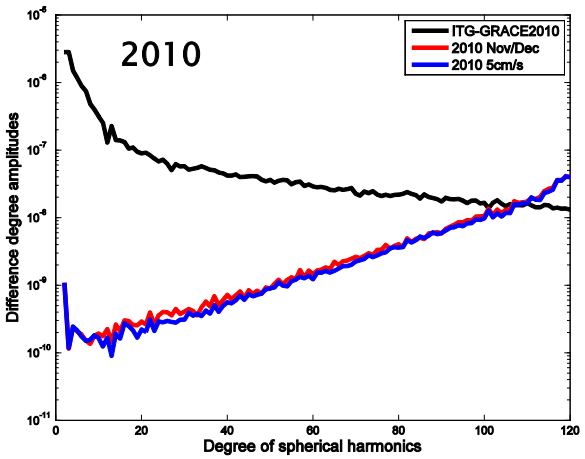
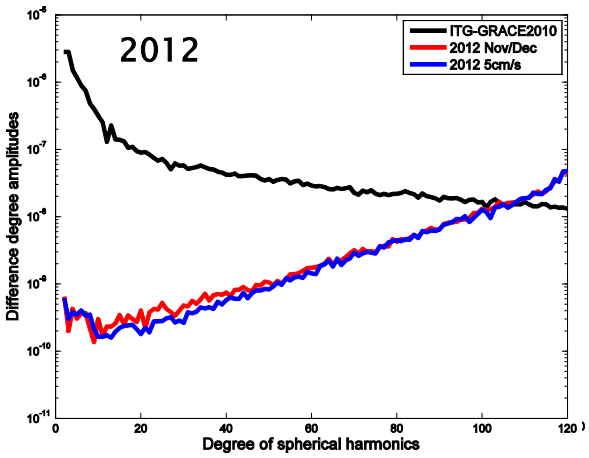
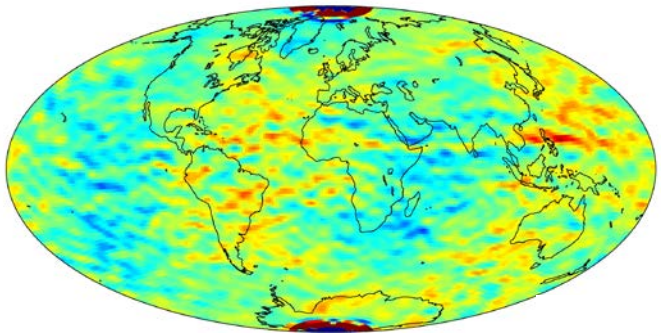
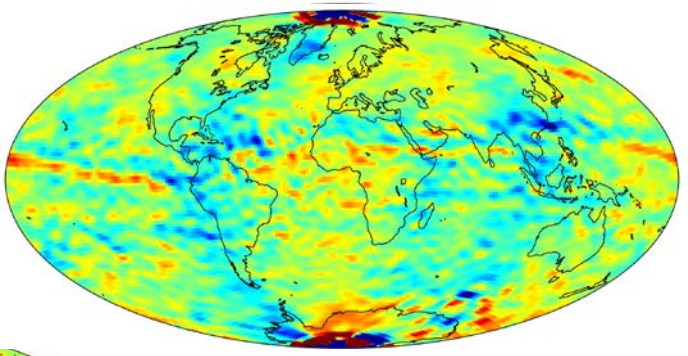
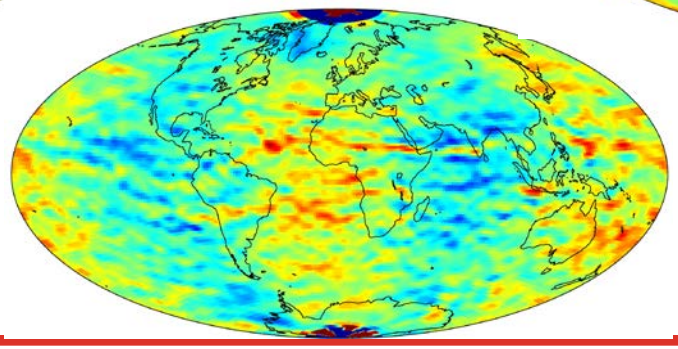




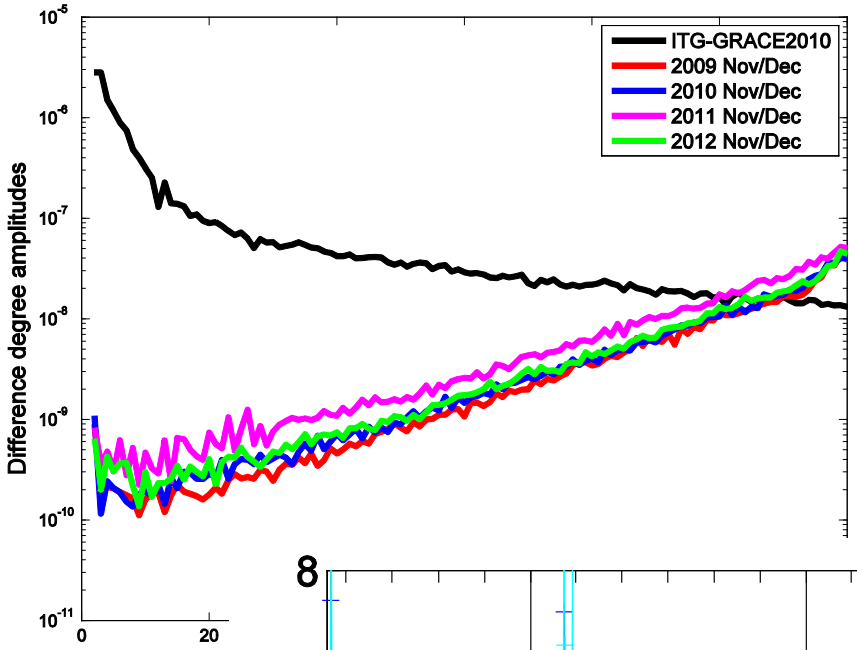


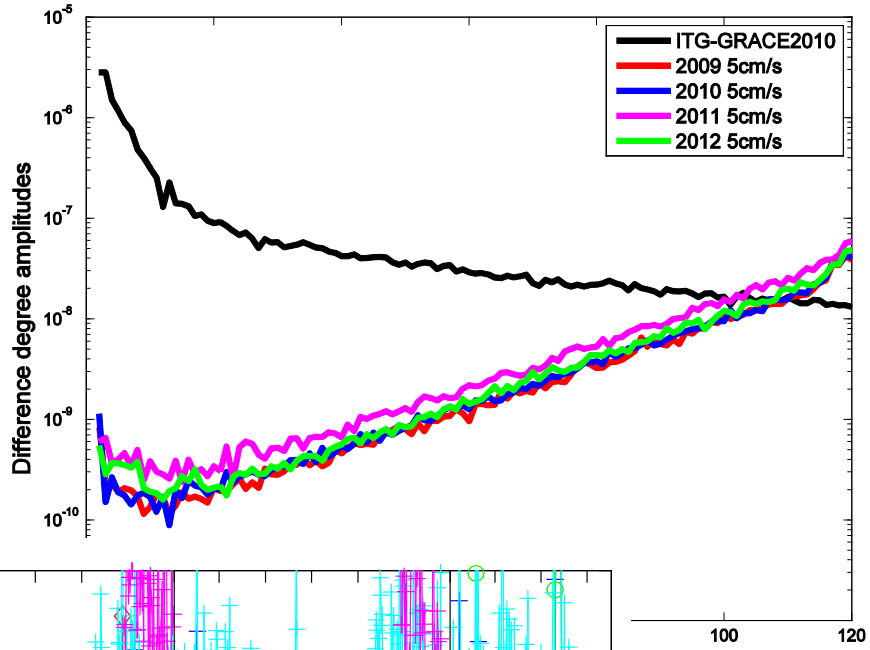


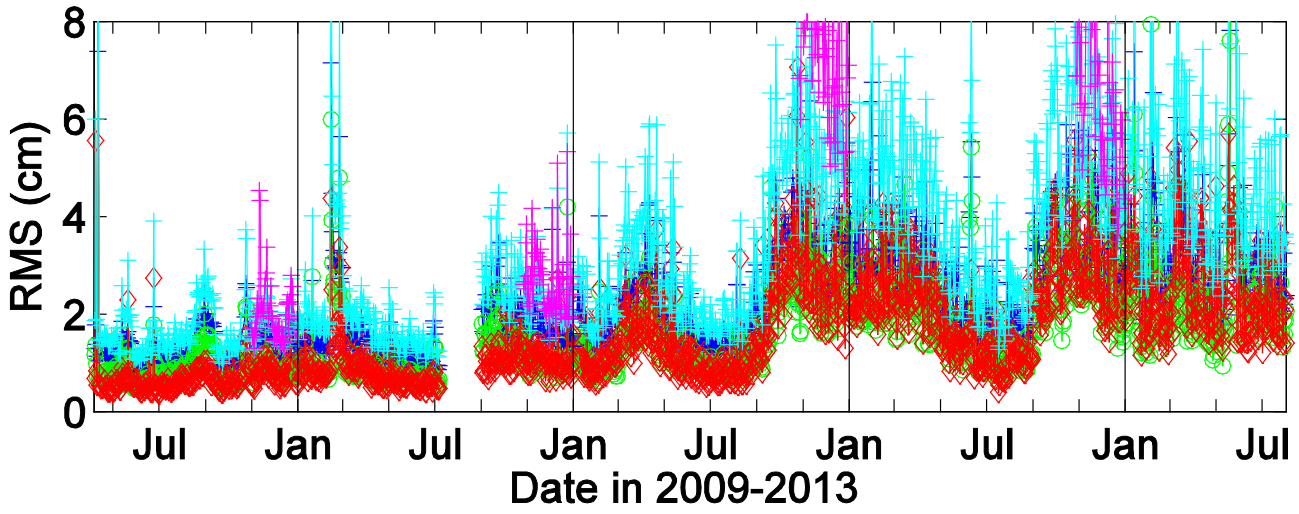




Removal of systematic orbit errors







Summary

- AIUB is providing the Precise Science Orbit product for the GOCE satellite
- The Celestial Mechanics Approach is applied to derive GPS-only gravity field models from the GPS-derived precise kinematic orbits
- Systematic orbit errors around the geomagnetic equator are mapped into the gravity field solutions
- Removal of GPS observations, which are affected by a ionosphere change of >5cm/s from one observation epoch to the next
- Systematic errors are removed but orbit quality suffers => more investigations necessary